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QoEWeb: Quality of Experience and User Behaviour Modelling for Web Traffic

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euroNF
NETWORK OF EXCELLENCE

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- **http://www3.informatik.uni-wuerzburg.de/research/projects/qoeweb/**

Motivation

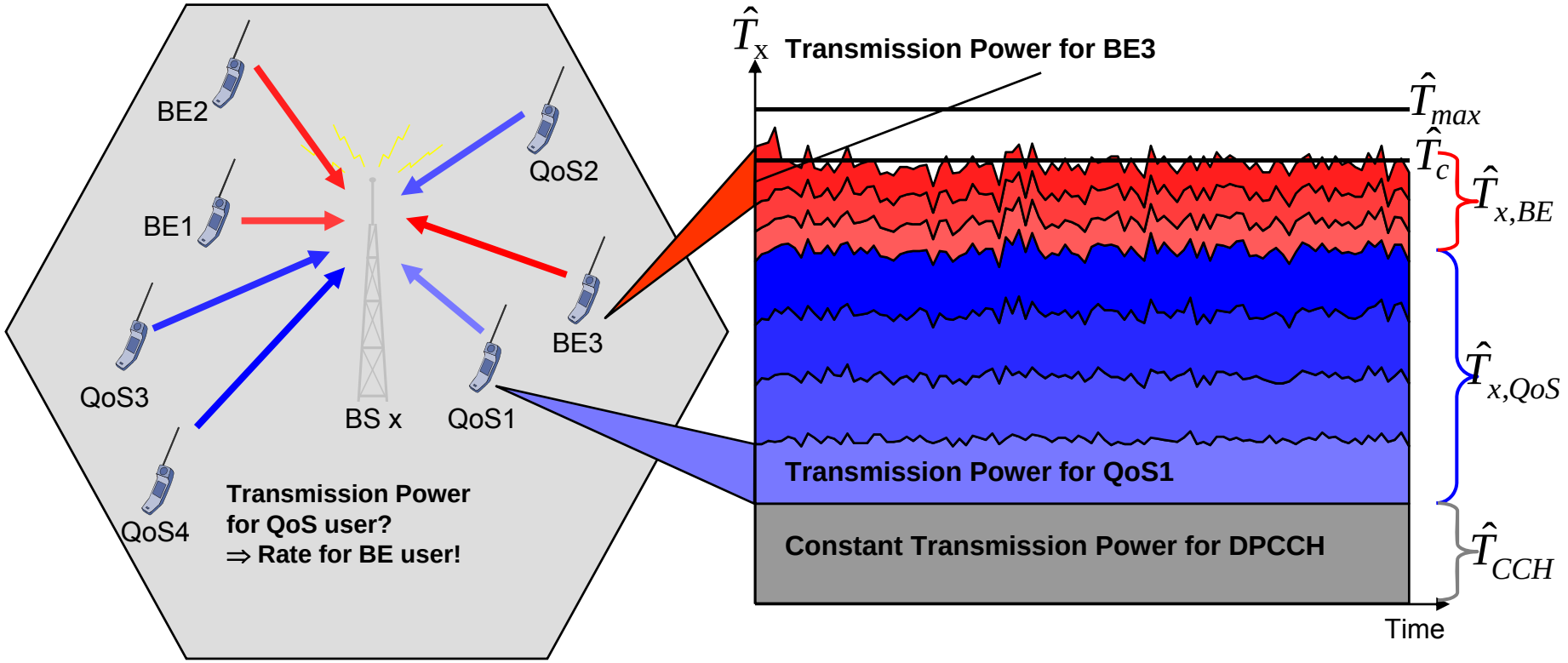
- User behavior strongly influences systems
  - e.g. selfishness, churn, or pollution in P2P systems
  - time-based or volume-based models in shared systems
- But, current web traffic models do not consider QoE / user behavior / impatience !
- Derive QoE and user behavior model for web traffic based on
  - active measurements in a laboratory test
  - passive measurements within an operator's network
- Apply model and evaluate its impact on selected examples
  - wireless networks with shared capacity
  - reputation management to react before the user reacts

Agenda

- Impact of User Behavior
  - Example: rate control in UMTS
- Active and passive measurements
- QoE and User Behaviour Modelling for Web Traffic
  - non-linear interdependency between QoE and QoS
  - timely behavior
- Reputation Management
- Work plan

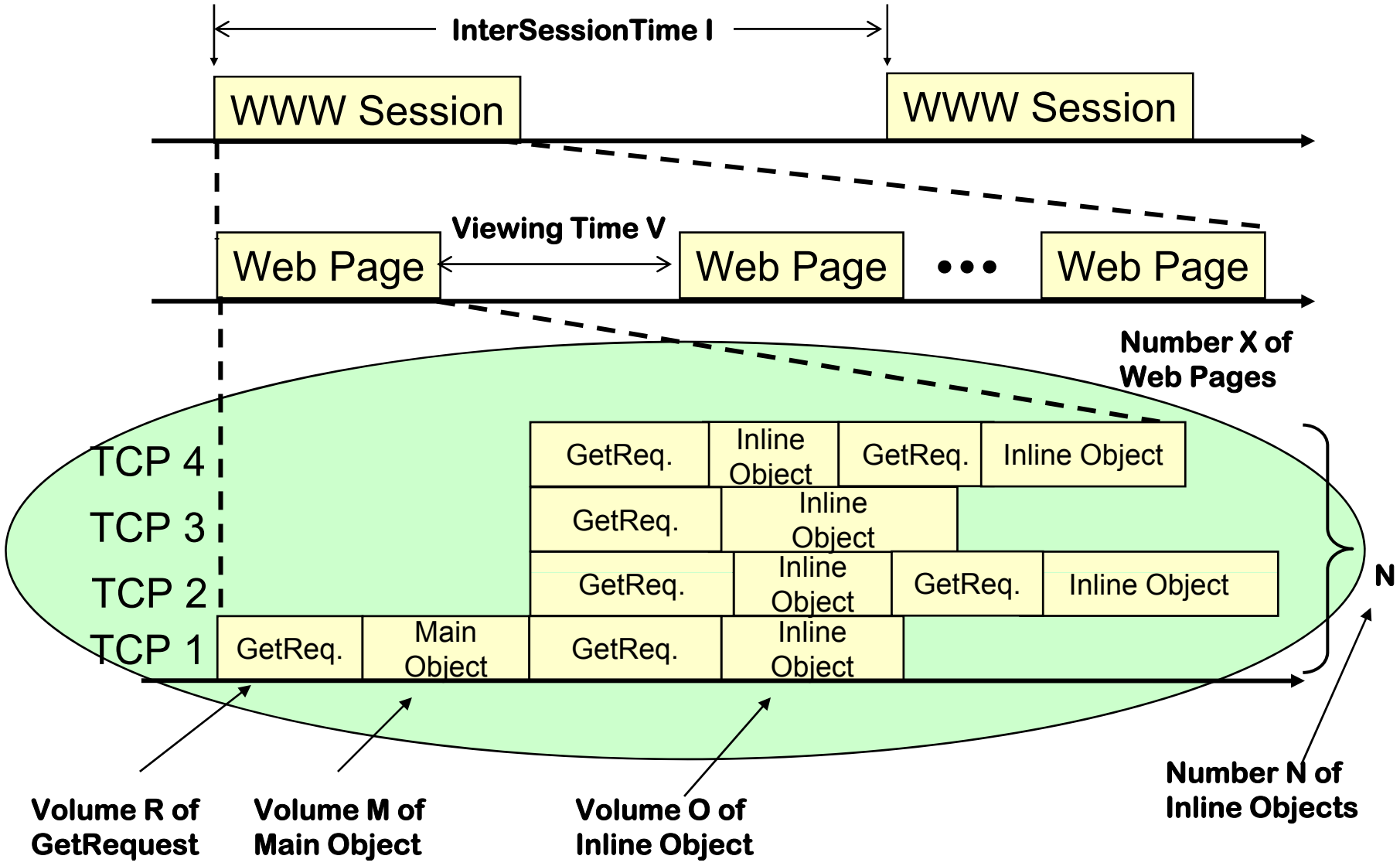
Example: Rate Control in UMTS Systems

- Best-effort user and QoS user with guaranteed bandwidth

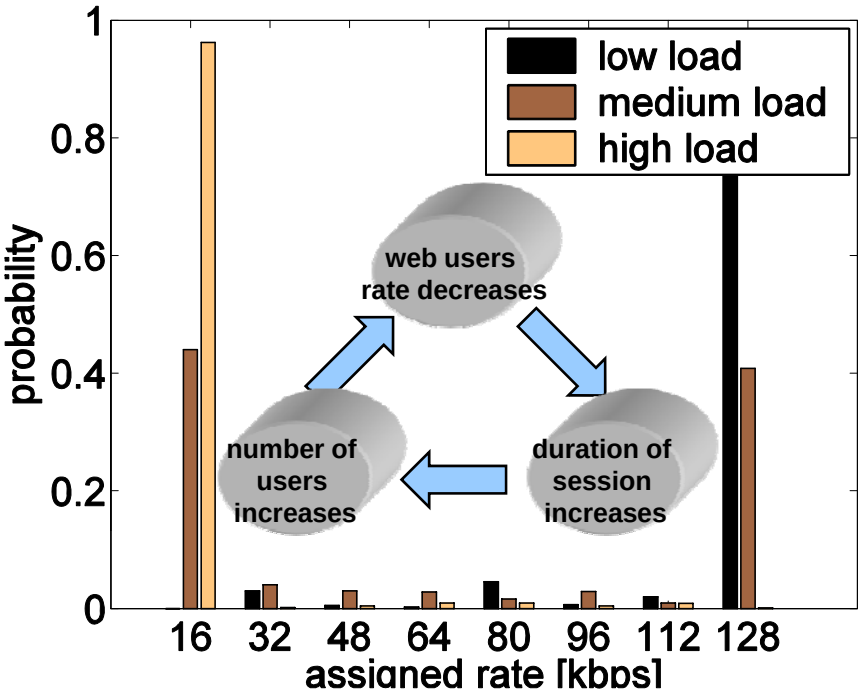


- **Time- and volume-based user: e.g. voice calls and FTP user**
- **Impact of user behavior on performance of system?**

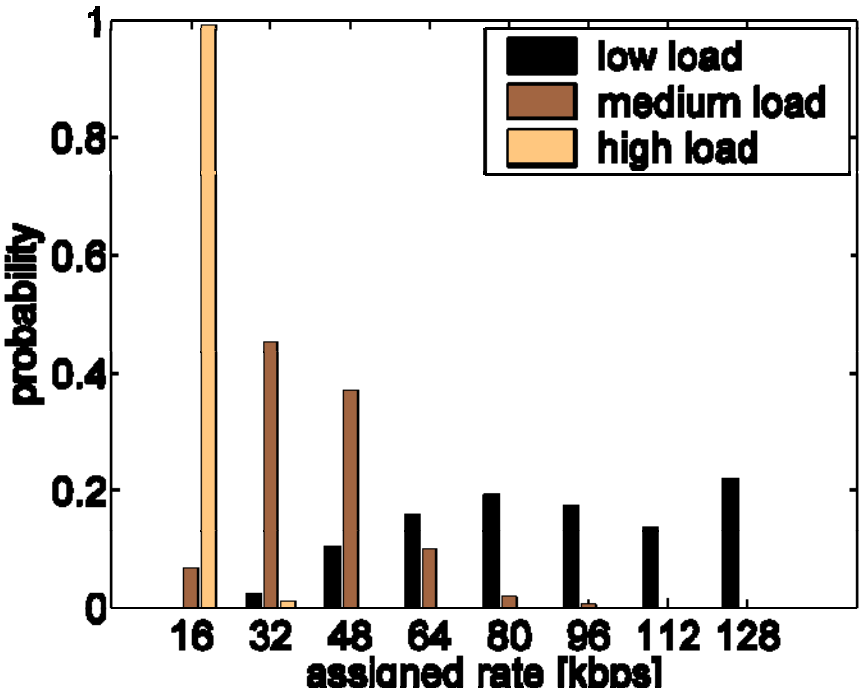
A Priori Source Traffic Model of a Web User



Simulation: Web Users in Rate-Controlled UMTS



volume-based users



time-based users

- **Different conclusions according to user behaviour model**
  - volume-based users: rate control degenerates?!
  - time-based users: rate control works as expected?!
- **Important to get realistic models**

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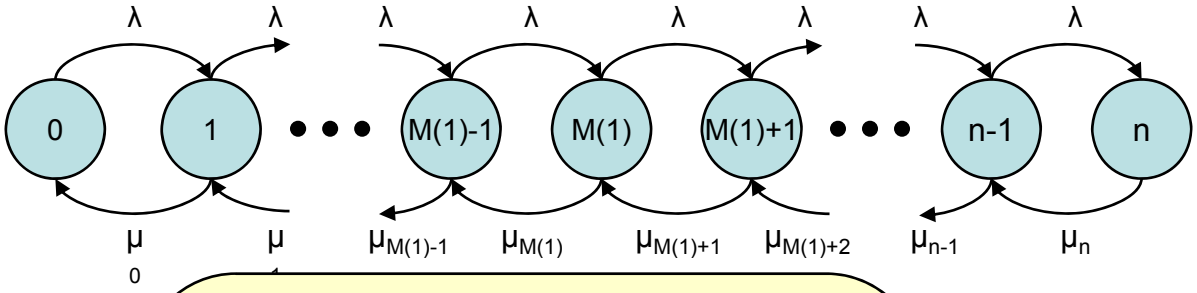
Basic Queueing Theory

- Birth-Death-Model



- Time

$$\left(\sum_{j=0}^{n} \frac{a^j}{j!} \right)^{-1}$$

- Volu

$$q(i,$$

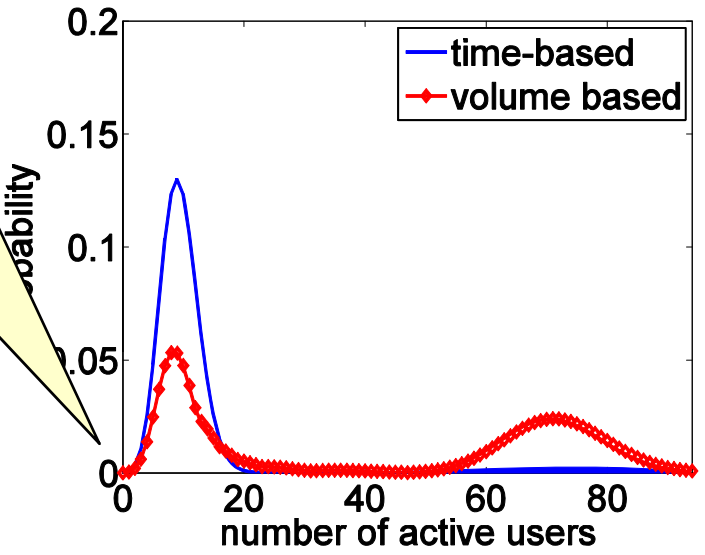
$$p(i)$$

$$\sum_{j=1} q(i,i-1)$$

Basic queueing theory leads to same qualitative results

→ understanding of system behavior

→ will be applied in QoEWeb



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Objectives of Measurements

- Active measurements
  - quantification of user impatience due to bad network conditions
  - quantification of the decrease of satisfaction as a function of time or actions
  - disturb QoS in laboratory environment → user survey
  - can also be applied to interpret passive measurements

- Passive measurements
  - investigate the statistical behavior of web traffic
  - analyze the correlations between the behavior of users and some network performance metrics

Passive Measurements: Traffic Modeling

- Daily behavior
  - Typical hours
- Model of web transfers / sessions
  - Traffic metrics: up/down volume, type of end
  - Network performance criteria: throughput, loss rate, RTT
  - Application level performance: response time, cancelled downloads
- Type of web transfers with similar characteristics
  - Aggregation in sessions (threshold ?)
  - Type of web servers
  - Influence of the hourly variations
- Model the behavior of web users, typology

Analysis of Correlations

- Correlation between traffic metrics and performance criteria
  - For web transfers / sessions / users

$\Rightarrow$ significant performance criteria, dependence function according to

  - the type of transfer / session
  - the type of users

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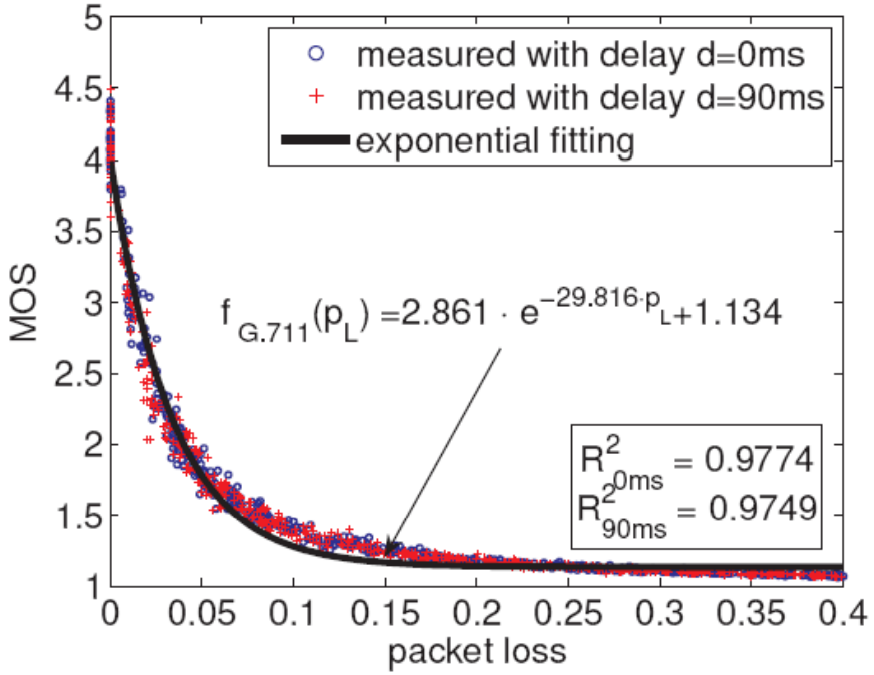
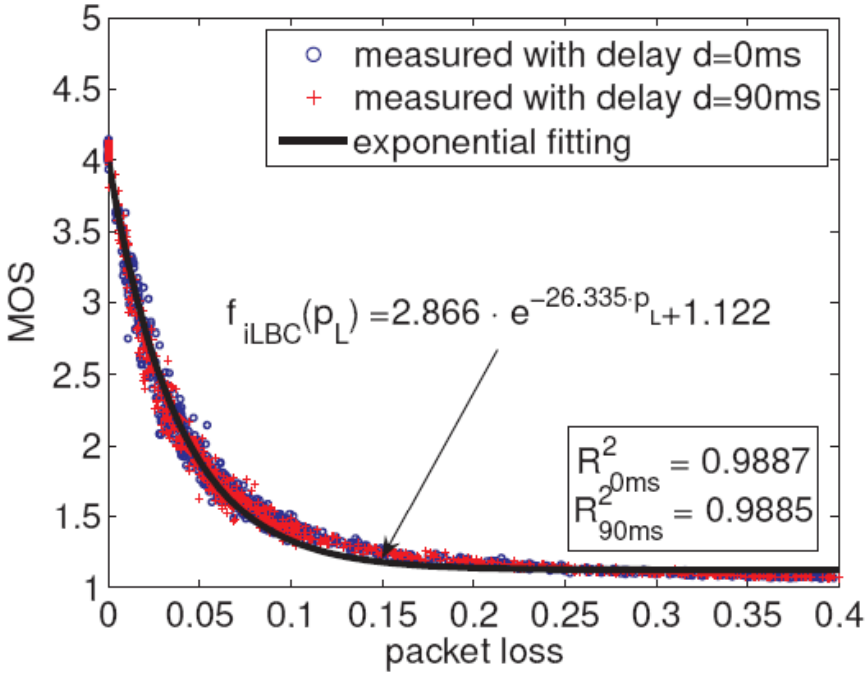
Interdependency between QoE and QoS

- Comparing iLBC and G.711 voice codecs
- Similar results for both codecs regarding packet loss
- IQX (exponential interdepency) cannot be rejected

G.711



iLBC



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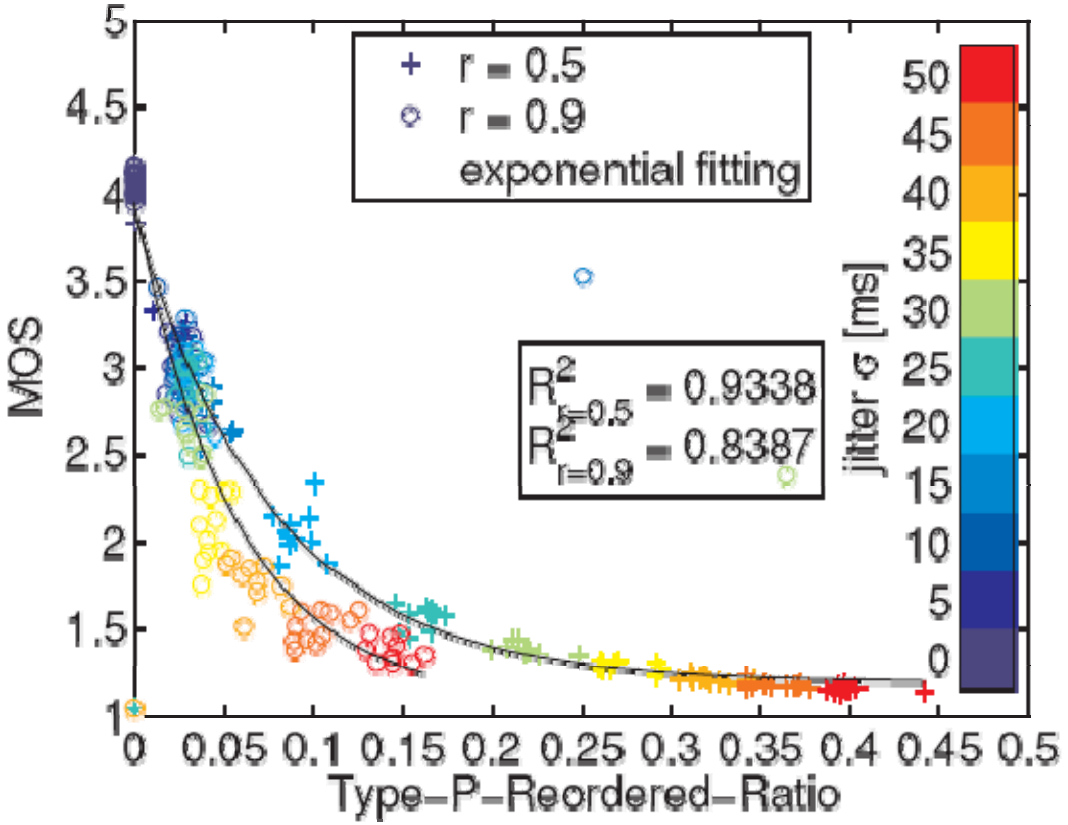
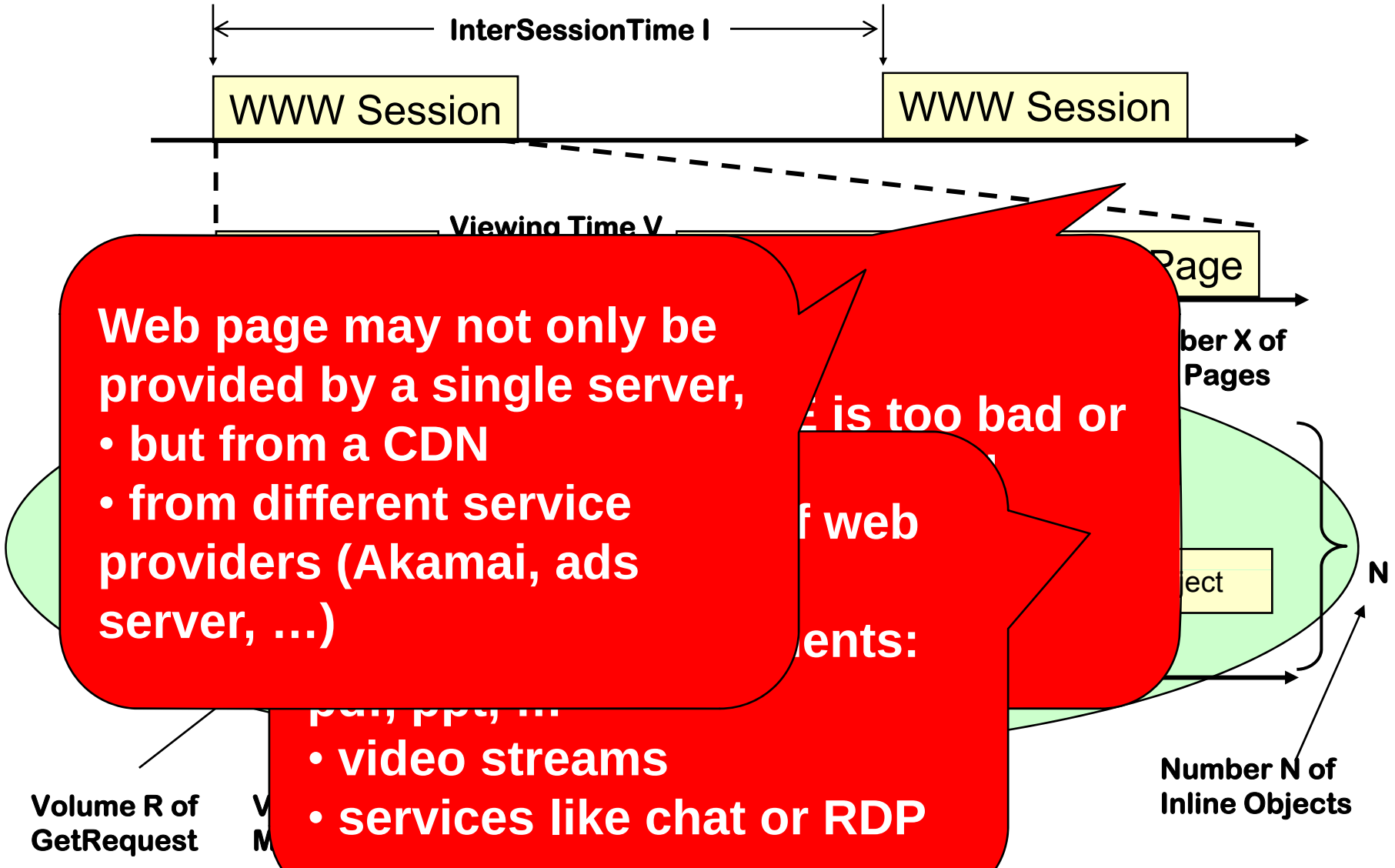
Impact of Autocorrelated Delays

- For different correlation factors, still exponential relationship valid
- Clear impact of correlation, i.e. **timely dependencies**, on QoE



Combining Active and Passive Measurements



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Reputation concept

- **Reputation** is a proven mechanism for reflecting aggregated level of trust to network services, users, shared resources (e.g. auctioning systems, P2P networks, distributed wireless networks such as MANET; eBay, eDonkey, SecMon)
- **Reputation management** is a feedback decision process being in charge of examining the given reputation (e.g. QoE, service performance) and triggering/enforcing remedy procedures on the on-line or threshold basis
- Key features of reputation
  - present and historical measurements are weighted and reflect an its evolution and dynamics
  - in distributed P2P environments reputation is shared among network nodes reinforcing decision process
  - based on historical measurements estimates future expectations

Reputation application in QoEWeb

- Reputation building
  - For a particular Web service/Web traffic a perceived level of user satisfaction *ST* is expressed by **QoE metrics** and quantified according to the created model of user behaviour
  - Own experience *OE* of reputation is fed by *ST,* applying **historical data** shaping with WMA function γ
  - For **shared reputation** *V* service reputation *SR* is created with respect to credibility of recommenders *IR*

- Reputation usage in QoEWeb
  - Evaluation of **QoE metrics dynamic** with respect to a particular Web services (web surfing, high throughput data, live streaming, interactive real time communication, etc)
  - **Detects deterioration of networks performance** before the user perceived QoE goes down below a critical level

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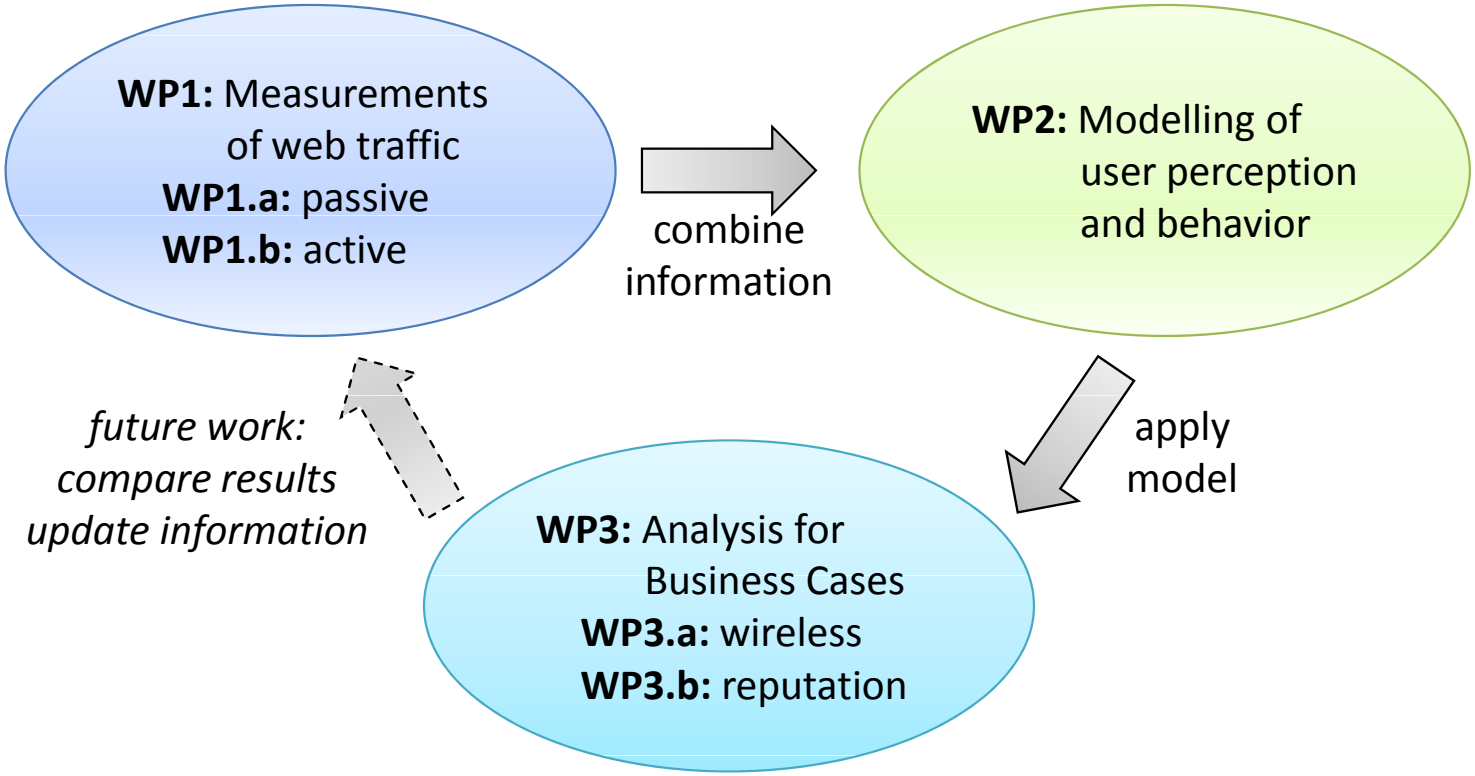
Work Plan



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